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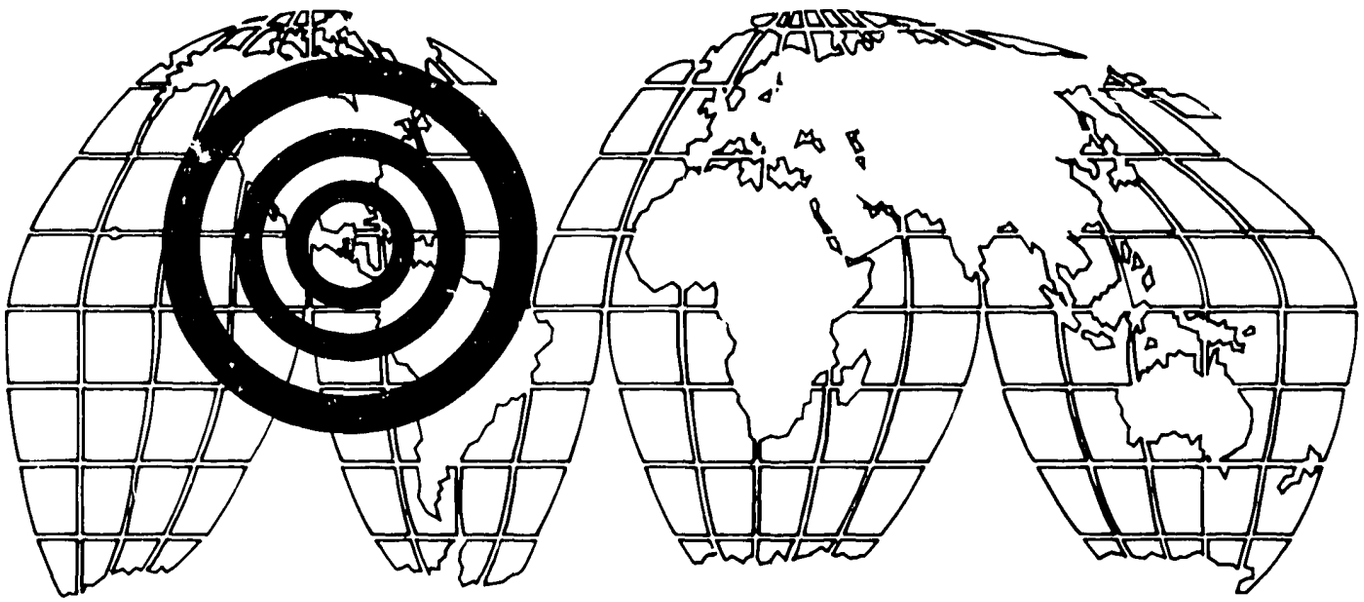
Guatemala: Development of the Institute of Agricultural Science and Technology (ICTA) and its Impact on Agricultural Research and Farm Productivity



February 1982

U.S. Agency for International Development (AID)

PN-AAJ-178

GUATEMALA: DEVELOPMENT OF THE INSTITUTE OF AGRICULTURAL SCIENCE AND TECHNOLOGY (ICTA) AND ITS IMPACT ON AGRICULTURAL RESEARCH AND FARM PRODUCTIVITY

PROJECT IMPACT EVALUATION NO. 30

by

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U.S. Agency for International Development

February 1982

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FOREWORD

In October 1979, the Administrator of the Agency for International Development (AID) initiated an Agency-wide ex-post evaluation system focusing on the impact of AID-funded projects. These impact evaluations are concentrated in particular substantive areas as determined by AID's most senior executives. The evaluations are to be performed largely by Agency personnel and result in a series of studies that, by virtue of their comparability in scope, will ensure cumulative findings of use to the Agency and the larger development community. This study, Guatemala: Development of ICTA and Its Impact on Agricultural Research and Farm Productivity, was conducted in May 1980 as part of this effort. A final evaluation report will summarize and analyze the results of all the studies in this sector, and relate them to program, policy, and design requirements.

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SUMMARY

During the decade of the sixties, food production in Guatemala barely kept pace with the demands of a growing population. In 1970, the Government of Guatemala initiated a restructuring of public agencies to provide coordinated service to small food-producing farms. An innovative organization, the Institute of Agricultural Science and Technology (ICTA), emerged from this restructuring with responsibilities for generating and promoting the use of improved technologies in basic food crops. AID supported this restructuring with a series of loan and grant projects beginning in 1970.

In 1975, AID approved the Food Productivity and Nutrition Project. Its purpose was to increase the production and nutritive quality of basic food crops in Guatemala and to strengthen and develop ICTA as an institution. Of $1.73 million allocated for the project, $1.2 million was for expatriate technical assistance, including plant breeding experts and other technicians who staffed ICTA while project-sponsored Guatemalans were being trained to assume positions within the new Institute.

Three crops, maize, beans, and sorghum, were targeted for increased production. Working with experts from international agricultural research centers, ICTA personnel developed new varieties and tested them under small farm conditions by collaborating with farmers. With the assistance of the Inter-American Development Bank, a seed service was organized to process seed and help maintain genetic quality.

New varieties of both maize and beans were introduced and increased yields have been recorded. Using improved seed and other technologies recommended by ICTA, collaborators have obtained increased yields. Gains in maize have been primarily in lowland varieties, but one new highland variety is promising. The impact of new seed on maize production is expected to increase as the amount of seed produced increases.

New varieties of beans may reduce or eliminate the need for costly programs to control Golden Mosaic. New varieties of sorghum were not released until 1980 and thus could not be evaluated. However, they appear markedly superior to previously available varieties.

In addition to developing and recommending improved seed, ICTA developed and recommended other farming practices related to increased yields, such as planting distances, seed densities, fertilizer applications, and weed and insect control. Indices of acceptance developed by ICTA indicate that increasing numbers of farmers who have collaborated in the field testing of such new technologies are adopting ICTA recommendations. Interviews with ICTA personnel and with individual farmers support this impression.

The AID project facilitated and hastened the strengthening of ICTA as an institution. The number of ICTA staff increased and staff qualifications improved. Expatriates facilitated the research work of ICTA and its growth as an organization. With project support, 10 Guatemalans received advanced

training and by 1979 and 1980, they were returning to ICTA to replace expatriates.

However, high attrition rates among personnel with advanced degrees are a serious problem for ICTA. Rigid salary schedules are apparently responsible, but ICTA managers have been unsuccessful in efforts to obtain the authority to revise these schedules. With the departure of expatriate advisors, these high attrition rates may make sustaining and expanding the present ICTA system more difficult.

Some confusion remains regarding the respective roles of ICTA and DIGESA, the extension service of the Ministry of Agriculture, particularly as ICTA's approach to research draws on some techniques of traditional extension methodology. ICTA and DIGESA are working on this problem, and it seems likely that new patterns of relationships will develop.

ICTA has come to represent a new model for agricultural research that planners and researchers in other countries are studying and attempting to replicate. If there is continued and increased support from the Government of Guatemala, it will be able to sustain and expand its present activities.

ACKNOWLEDGMENTS

The team thanks the Institute of Agricultural Science and Technology (ICTA) for supporting and assisting this evaluation. Marc Antonio Martinez, of the socioeconomic section, escorted the team and facilitated access to both information and personnel. ICTA data and reports were consulted. Regional directors and other personnel within ICTA, the Directorate General of Agricultural Services (DIGESA), and the National Agricultural Development Bank (BANDESA) talked openly with team members. In addition, 30 farmers who were collaborating with ICTA and its sister agencies gave freely of their time to answer questions during farm visits. The team is grateful to all of these persons for their assistance and cooperation. ICTA has earned a reputation as a candid organization that shares openly with others. The team's experiences corroborate that impression. Finally the team expresses its gratitude to the USAID Mission for the assistance provided.

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PROJECT DATA SHEET

1. Country: Guatemala

2. Project Title: Guatemala Food Productivity and Nutrition Improvement

3. Project Number: 520-11-130-232

4. Project Implementation:

   a. Project Authorized--1975
   b. Final Obligation--1979
   c. Final Input Delivery--1980

5. Project Completion--Final Disbursement: Fiscal Year 1980

6. Project Funding:

a. AID Predecessor Projects:	
Rural Development (loan)	$ 675,000
Agricultural Development (grant)	380,000
b. AID Food Productivity and Nutrition Improvement Project	1,700,000
c. Other Donors:	
Rockefeller Foundation	1,500,000
Inter-American Development Bank	2,100,000
Grand Total	$6,355,000

7. Evaluations: 1975, 1976, and 1978

8. Responsible Mission Officials During Life of Project:

   a. Mission Directors: Robert Culbertson, Edward Coy
   b. Project Officers: Carl Koone, David Schaer, Clem Weber

9. Host Country Exchange Rates:

   a. Name of Currency: Quetzal
   b. Exchange Rate at Time of Project: Q1 : $1

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GLOSSARY

BANDESA	Banco de Desarrollo Agricola (Agricultural Development Bank)
CIMMYT	Centro International para Majoramiento de Maiz y Trigo (International Center for Maize and Wheat Improvement), Mexico
CIAT	Centro International de Agricultura (International Center of Tropical Agriculture), Colombia
DIGESA	Direccion General de Servicios Agricola (General Agricultural Services Bureau), Ministry of Agriculture, Guatemala
ICTA	Instituto de Ciencias y Tecnologia Agricola (Institute of Agricultural Science and Technology)
IDB	Inter-American Development Bank
INDECA	National Agricultural Marketing Agency
Hectare (Ha)	2.5 acres
Manzana (Mz)	0.7 of a hectare, about 1.7 acres
Plan Puebla	A CIMMYT project in Puebla, Mexico, that pioneered methodologies of working closely with the farmer in technology innovation.
Quetzal	Guatemala currency unit, equal to one dollar


MEXICO
BELIZE
Gulf of Honduras
Lago de Izabal
HONDURAS
EL SALVADOR
Pacific Ocean
Totonicapan
Quezaltenango
Guatemala
Mazatenango
Champerico
Cuilapa
Jutiapa
Guatemala
International Boundary
Capital
Sites Visited
0 25 50 Miles
0 25 50 Kilometers

I. PROJECT SETTING

A. Stagnating Agricultural Productivity

In the late 1960s, the Government of Guatemala conducted a comprehensive assessment of its rural areas. The assessment indicated that food production was just barely keeping pace with growing demand and that rural incomes and farmer productivity were stagnating. Minimal increases in production had been achieved primarily by increasing the land area devoted to agriculture. Particularly affected were the bean and maize staple food crops. Although bean production had doubled between 1960 and 1970, total acreage had increased almost three times. During the same period of time, yields of maize, the most important food crop in Guatemala, had scarcely increased at all. While the export subsector of agriculture contributed $211 million of foreign exchange in 1972, well above the $21 million agricultural import bill, the country still had to import maize and beans. Increasing amounts of foreign exchange were being allocated to purchase basic food imports. Complicating the problem, it was observed that the availability of sufficient arable land was becoming a major constraint to maintaining needed production levels.

To correct this situation, the five-year development plan issued in 1970 responded by initiating fundamental changes in the structure of the public agriculture sector. For the first time, significant public funds were allocated for improving small farmer productivity through the creation of an improved agricultural service system. Within the public agricultural sector, semiautonomous institutes were created to serve the small-farm food-producing sector. The first two institutes formed were the National Agricultural Marketing Agency (INDECA), with responsibilities for marketing, and the National Agricultural Development Bank (BANDESA), with responsibilities for credit services. Initially research and extension functions were retained within the Ministry of Agriculture in a centralized agency, the Directorate General of Agricultural Services (DIGESA). Beginning in 1970, AID provided developmental assistance to these new agencies. This restructuring consolidated functions and decentralized control by dividing Guatemala into homogenous agro-ecological regions where services could be better coordinated.

B. ICTA's Origin

Continuing this restructuring process, agricultural research responsibilities were subsequently assigned to the Institute of Agricultural Science and Technology (ICTA), a new institute created in 1973. Like the other semiautonomous institutes, ICTA was organized outside the Ministry of Agriculture, but with a board of directors chaired by the Minister of Agriculture. The semiautonomous status of the institutes provided them with flexibility to plan and implement new programs, hire personnel, and make independent contractual agreements. In the absence of rigid guidelines, planners hoped that ICTA would develop new operational methodologies to link

the needs and concerns of farmers more closely with the generation and testing of new technologies.

ICTA was carefully designed to address four specific problems identified during the rural sector assessment: (1) the lack of an adequate technology for the small farmer, (2) inadequate farm testing of the technology being recommended, (3) lack of evaluation of farmer acceptance of a recommended technology, and (4) the researchers' lack of knowledge of farmer problems and their insufficient contact with the extension agents.

Planning for ICTA development took two years, involved five work groups including scientists from Guatemala and other Latin American countries, and personnel of both AID and the Rockefeller Foundation. The experiences from similar international agricultural research projects were carefully considered. The International Center for Maize and Wheat Improvement (CIMMYT) Plan Puebla Project in Mexico was particularly important. This project was a pioneer effort in bringing research into closer contact with both the farmers and extension agents. Another antecedent was the AID-predecessor Point IV program in Guatemala which helped establish a research service in the Ministry of Agriculture. Guatemalan scientists from this research-education tradition played a major role in the creation of ICTA.

Both AID and the Rockefeller Foundation played major roles in developing and implementing the new organizational structure. AID's intimate participation with this important research initiative and close coordination with the Rockefeller Foundation over a long period permitted it to play a major role in policy and strategy formulation.

C. Traditional and ICTA Models of Agricultural Research

To fully appreciate the significance of ICTA and the research methodology developed, its divergence from traditional approaches to agricultural research must be recognized. In the traditional model, research and extension are separate processes. Scientists working in experiment stations conduct research and develop new technologies. Recommendations are communicated to farmers through extension service workers who make farm visits, prepare demonstration plots, and issue publications. Through these promotional activities, it is expected that farmers will recognize the advantages of the new technologies and will adopt them as their own.

Station research is conducted along commodity lines with the roles of the various disciplines carefully defined. Research in plant breeding, for example, is conducted independently of research in soils. Biological and physical scientists predominate in technology development.

In the traditional model, yield optimization rather than profitability enhancement objectives are emphasized. New technologies that increase productivity are assumed to be applicable and beneficial to all farmers. Although large farm operators may be the first to accept the new technologies, it is assumed that eventually small farm commercial operators will follow suit through the process of technology "trickle down." Nonadopters are

considered to be resistant to change because of "laziness" or "irrational behavior."

ICTA was organized around an innovative concept and style of operation that has come to be called "farming systems research" (although ICTA itself makes almost no use of that term). This operating style brings the research entity into much closer contact with the farmer-client than does the traditional research methodology. The ICTA approach accomplishes two things. By helping research personnel to know and to understand the farmer, it enables them to direct their research efforts to seeking technology improvements that are relevant to his system. Because ICTA was assigned the small farm operator as its exclusive client, it directs its efforts toward generating technology relevant to small farm systems. Secondly, innovations are tested by small farmers in their system before being released or recommended for use on small farms. The style involves on-farm research, with minimal experiment station research. The ICTA system deemphasizes the experiment station. ICTA has no central research station. Its regional stations, called "production centers," are neither large nor elaborately equipped. The maintenance of genetic purity and most of the plant variety crossings are done here. Almost everything else is done on farms. Laboratory facilities are also meager. Most research (75 percent) takes place on individual farms with only 25 percent of research being conducted on experiment station sites. Farmers collaborate in the process of research by employing recommended practices and by evaluating the results and opinions as to appropriateness. Employing this approach, farmer confidence with new technologies results in considerable informal dissemination to other farmers even before information is released to extension workers and officially promoted. Accordingly, the traditional gap separating agricultural research and extension is significantly reduced.

In the ICTA model, research is directed toward specific agro-ecological areas representative of a larger universe. The focus is on technologies that can be implemented and that are profitable for use by the small farm producers.

Research is conducted by interdisciplinary teams. The knowledge of various disciplines, such as plant breeding, entomology, economics, and sociology, is focused on a particular crop or a prevalent mix of crops appropriate to the mixed cropping activities employed within the farm enterprise. Social scientists contribute by studying how farmers make management decisions and how innovations can be introduced which are respectful of family labor constraints, customary behavior patterns, and cultural practices. Input/output budgets to assess the profitability of each recommendation are carefully developed and analyzed.

Thus, while the traditional model represents a unidirectional flow of information from scientists to farmers, the ICTA model represents a multidirectional flow of information among scientists in different disciplines and farmers who are collaborators in the research and testing of new technologies. Appendix B provides a more detailed explanation of the traditional and ICTA approaches to agricultural research.

D. ICTA's First Two Years

During ICTA's first two years of operation, the traditional organization of departments on the basis of agricultural disciplines was changed. Instead, a National Commodity Programs system was developed which brought together the various scientific disciplines to focus on specific crops. Experiment stations were renamed "Production Centers" and became the headquarters of ICTA in each region. Farm-level testing of existing technological information and plant varieties was initiated in three areas.

ICTA leaders assisted by expatriate advisors developed guidelines for conducting farm level research. These guidelines were flexible so that research methodologies could evolve out of the experiences gained in the field. ICTA planners also specified that they should determine farmer acceptance or nonacceptance by introducing these new technologies to farmers directly and incorporating farmer evaluations into the research effort.

Initially, as the research facilities and functions were transferred from DIGESA to ICTA, the two organizations cooperated closely. However, frictions soon developed. ICTA was assuming not only the research responsibilities formerly assigned to DIGESA, but according to DIGESA was also taking on some of the unspecified responsibilities for "extension" which were DIGESA's domain. Some of DIGESA's most talented people accepted positions in the new institute. ICTA personnel were better paid and were free of some of the Ministry of Agriculture regulations that constrained DIGESA personnel. Furthermore, as a new organization, ICTA was receiving considerable attention, both nationally and internationally.

The ICTA organizational and technology development system is presented in detail in Appendix B.

II. PROJECT DESCRIPTION

During a five-year period, beginning in 1976, the Food Productivity and Nutrition Improvement Project's aim was to increase the production and nutritive quality of basic food crops in Guatemala and to strengthen and develop ICTA. AID obligated $1,730,000 to provide research and outreach programs designed to increase yields of Guatemala's basic food crops and to improve human nutrition through the development and utilization of high-yield food crops with improved nutritional value. The Mission estimates that additional support to ICTA from two earlier projects amounting to over $950,000 was provided as a result of a restructuring of the public agriculture sector. That included almost 10 person-years of technical assistance in beans, vegetables, and regional research and extension coordination.

At the time the project was approved, high-lysine maize was being intensively tested by AID's Technical Assistance Bureau (TAB), CIMMYT, and others. This new maize contained larger amounts of the amino acid lysine and this significantly improved its protein quality. Project plans called for the creation of a special unit in ICTA to work on high-lysine maize, but

these plans were subsequently set aside because no genetic material suitable for the highlands was available. Instead, the project focused on conventional maize, Guatemala's predominant food crop and most important staple food.

The Project funds were allocated for technical assistance, participant training, and equipment. Most of the AID resources ($1.2 million) supported expatriate technical assistance, including plant breeding experts from Texas A & M University, the International Tropical Agriculture Center (CIAT), and other expatriate technicians who staffed ICTA while Guatemalans were receiving advanced degree training. The quality of the technical assistance provided and the way in which it was employed were important factors in the successful institutional development work that was observed. Most of the expatriate assistance was in line positions. For example, two leaders of the three original regional production teams were AID-supported contract personnel. One of them was later transferred into the position of technical director, where he supervised all technical operations. The other served as training supervisor as well as production team leader before becoming leader of the national sorghum program. Both were replaced as production team leaders by Guatemalans, and all teams in the newly activated regional programs were staffed by Guatemalans.

The project used a variety of contractors, each of which made a major contribution. The sorghum breeder and several other technicians were provided through Texas A & M University. Two maize breeders were contracted from CIMMYT, and a CIAT contract provided two bean breeders. The plant breeding experts provided access to the world's best stock of germ plasm as well as other support. The technician promoted to the top technical position in ICTA was provided by a Puerto Rican consulting firm.

It is the consensus among ICTA personnel that this assistance was crucial. It performed several functions. First, it provided manpower to staff ICTA while its own people were being trained. Second, it provided ICTA with both technical competence and help in making its new concept operational. Finally, it facilitated the development of linkages with the international agricultural research centers and U.S. centers, which serve as repositories of the world's stock of commodity technology. Parenthetically, the work in Guatemala fed back into these worldwide entities to their own benefit.

The project provided $140,000 for the training of ICTA personnel in the United States and elsewhere. Additional funds were allocated for equipment needs, including pickup trucks, maize shellers, threshers, and other field equipment.

At the time the project was approved, ICTA was working in the Highlands (Quetzaltenango), Eastern (Jutiapa), and Coastal (La Maquina) regions, three major geographical areas where large concentrations of small farmers were producing basic food crops. ICTA operations were later expanded to include all six regions of Guatemala, although activities within two of the regions were on a reduced scale.

Other donor agencies were important to the project, and the Mission assumed its share of the responsibilities in orchestrating those efforts. The Rockefeller Foundation was heavily involved in the original design of ICTA, and, just as important, its personnel played key roles in resolving problems to make the concept operational. The Foundation provided a special consultant to the director general and an experiment station development specialist, both from its permanent staff. It provided the chief of the socioeconomics section for four years and the technical director for two years. The success of the AID project owes much to this group.

The Inter-American Development Bank handled the seed program, which was one of the originally designed delivery systems, via a loan for facilities and a grant for technical assistance.

The Food Productivity and Nutrition Improvement Project targeted three crops, maize, beans, and sorghum, for increased production. Maize is the most important food crop in Guatemala. Beans are the principal source of protein for most of the rural (and urban) poor. Sorghum was included because it is an important crop in the Eastern area and can be used in many of the same ways that maize is used.

III. PROJECT IMPACT

To completely separate the impact of the Food Productivity and Nutrition Improvement Project from the impact of other AID assistance is an impossible task. Even separating AID assistance from that provided by the Rockefeller Foundation and the Inter-American Development Bank is difficult. The three donors worked together exceptionally well in designing and implementing the new approach to agricultural research and in financing different aspects of a unitary effort.

A new seed delivery system, for example, was an integral part of the original AID project design. When the Inter-American Development Bank (IDB) expressed an interest in supporting this part of the project, AID retained contingency plans until the IDB commitment was firm. IDB provided a loan for facilities and a grant for technical assistance to enable the creation of this new seed delivery system. The team's evaluation of this new system is included because the merchandizing of improved seeds is an integral part of the impact of the AID project.

A. Impact on Crop Production

1. The Seed Delivery System

Before ICTA was created, the merchandising of seeds was under state control. With the development of ICTA, the Government of Guatemala modified its seed regulations and procedures to encourage the development of a privately controlled seed industry. Under the new system, ICTA works with international research centers to develop and test improved germ plasm. New

varieties are released to private growers who multiply them for the first-generation under ICTA supervision to maintain both genetic purity and freedom from weed contamination. ICTA provides its processing and storage facilities to the commercial growers for a fee, and the seed is labeled "ICTA certified." ICTA never takes ownership; growers are responsible for merchandising. After ICTA release of the seed, no public agency has authority to regulate the seed industry or maintain quality safeguards.

The evaluation team found this system to be working well at the present time, although the absence of regulation may lead to problems at a later date. Commercial seed growers sell first-generation seed as "ICTA certified." Second-generation seed is now being sold under brand names that associate it with ICTA, suggesting that the public has confidence in ICTA.

A calculation based on data provided by ICTA indicates that seed developed by ICTA was worth at least $10 million to Guatemalan agriculture in 1979, compared to the ICTA budget of $4 million. This calculation pertains only to that part of the ICTA genetic material which flowed through the ICTA seed system. Seed sales considerably decrease the Guatemalan foreign exchange levels previously spent on seed import. The data and calculations are shown in Appendix C. Field data gathered from the coastal area indicate that 95 percent of the farmers now use ICTA-developed varieties, compared with less than 50 percent in 1975 using improved varieties.

2. Genetic Improvement and Increased Yields

The AID evaluation team found that the project's investment in plant breeding and improved seed has resulted in increased yields of both maize and beans. All farmers visited spoke of the increased yields they attributed to ICTA technologies.

Using ICTA data on increased yields resulting from the production of ICTA-developed seed, the evaluation team calculates that improved seed for maize alone was worth more than $7 million to Guatemala agriculture in 1979.

Since there is a strong interaction between the genetics of the maize plant and the ecology of an area, ICTA has been working with a number of different varieties to accommodate the extreme variations of the Guatemalan climate. Most of the productivity gain thus far have come from lowland maize. In the highlands, no single improved variety has been found to produce greater yields than native varieties over a very broad area. However, a new variety -- Guatean Xela -- appears promising because it matures three weeks earlier than some of the native material. Since maize can barely mature in the 11-month growing season of the highlands, the earlier maturity of this new variety could be an important contribution in farming operations.

It is unlikely that Guatemalan maize will have much impact on other countries because maize is a highly site-specific crop. However, the methods being used for maize improvement by ICTA, in collaboration with CIMMYT, are based on open pollination, and varieties within Guatemala can be expected to improve steadily over time, even without the release of new varieties.

Furthermore, the impact of ICTA maize seed is expected to increase through increases in the number of seed producers and the amount of seed produced. ICTA's goal is to produce 3.8 million pounds of seed maize in 1980 and 6 million pounds per year by 1985. In 1978, ICTA was producing less than 1.8 million pounds of seed maize.

With beans, the evaluation team found the impact of the project's investment to be most pronounced in the area of disease. Using ICTA data on increased yields resulting from the production of ICTA-developed seed, improved bean seed available was estimated to be worth only $32,000 to Guatemalan agriculture in 1979.

However, in the lowlands, as in other parts of the world, beans have been plagued by the Golden Mosaic, a devastating disease carried by the white fly. A Colombian variety of bean, Suchitan, was introduced into Guatemala and approved for multiplication in 1977. In 1979, enough seed was produced to plant about 1,700 acres in 1980. This new variety shows considerable promise. In ICTA on-farm tests, Suchitan, under severe attack by Golden Mosaic virus and without treatment had yields about equal to the best of Guatemala's varieties which were grown under an ideal and costly disease-control program. Three varieties with a higher level of tolerance than Suchitan to Golden Mosaic were released in 1980 and may represent a genetic breakthrough.

The evaluation team was unable to assess the project's investment in sorghum. Since no new sorghum material passed through the ICTA seed system in 1978, data were not available to calculate increased yields. Prior to 1975, with AID assistance, ICTA had produced some improved sorghum and distributed enough seed to plant 4,500 acres. The impact of this earlier assistance was not evaluated.

In 1980, however, ICTA released four new varieties of sorghum that appear to be markedly superior. They have been widely tested in ICTA farm trials and observed by farmers in 25 field days. Their yields in 1979 averaged 300 percent higher than traditional native varieties. Common native varieties flower in 165-170 days. ICTA has developed materials that flower in 135 days. These new varieties could enable sorghum to be produced in areas in which the rainy season is too short for any of the native varieties.

One of the new varieties has a gene that increases the photosynthetic efficiency of the crop so that some high-yielding temperate zone sorghum varieties yield equally well in the shorter days of the tropics. Another variety has a cooking quality that is almost equal to that of maize, both in home cooking and in commercial products. Several companies have shown interest in the new sorghums for use in snack and specialty foods, in baby foods, and as an extender of wheat flour. These new varieties show promise of having a significant impact on sorghum production in Guatemala and in other countries also.

3. Improved Farmer-Accepted Practices

In addition to developing and recommending improved seed, ICTA develops and recommends other farming practices related to increased yields. These may include recommended planting distances, seed densities, fertilizer applications, and weed and insect control. Since recommended practices vary from region to region, both in substance and in value to the farmer, the extent of acceptance is difficult to measure, and any relationship between acceptance and increased yields is impossible to isolate from other contributing factors.

Within each region, however, ICTA does calculate an Acceptance Index for each recommendation. This index represents the percentage of collaborators continuing to use a recommended technology multiplied by the percentage of their land on which they are using it. Fifty has been established as the Acceptance Index required before ICTA considers the new technology satisfactory. This is a stringent test; all farmers could be using the new technology and the Acceptance Index could still be less than 50.

The Acceptance Index was not designed for impact evaluation. It records acceptance for a changing group of ICTA collaborators. Measurements are taken only during the first year after collaborators have participated in an ICTA field test. Thus, no inferences can be drawn regarding mass acceptance. In spite of these limitations, the Acceptance Index offers the only statistical information available on the "acceptance" of ICTA technology.

The evaluation team examined the 1979 Acceptance Indices for maize production in two geographic regions of Guatemala--the Highlands (Totonicapan) and the Coast Area (La Maquina). A detailed analysis, reported in Appendix D, reveals that Acceptance Indices in both areas were noticeably increasing over the five-year period 1975-1979. In the Highlands, where subsistence farming predominates, two out of five indices had reached 50 by 1979; in the Coastal Area, where small commercial farms predominate, indices for three of the four recommendations surpassed 50 in both 1978 and in 1979.

The Acceptance Indices in these two areas suggest that increasing numbers of farmers who have collaborated in field testing of technologies recommended by ICTA are adopting these recommendations. Interviews with ICTA personnel and with individual farmers supported this impression.

Two specific examples of ICTA's impact in improving farm practices came to the attention of the evaluation team. In the Highlands, where fertilizer is essential and costly, farmers had been using a fertilizer containing equal parts of nitrogen and phosphorus, even though the needs for nitrogen were much greater. Thus to apply adequate nitrogen, it was necessary to waste phosphate. One farmer visited by the evaluation team estimated that by using ICTA technology--spacing, rate of seeding, and nitrogen fertilizer--he had doubled production while reducing fertilizer cost by one-half.

In the Coastal region (La Maquina), ICTA field tests revealed that the use of fertilizer did not increase yields significantly. These findings

were shared with BANDESA, whose Regional Credit Office was at this time requiring borrowers to use fertilizer. As a result, the fertilizer requirement was eliminated by BANDESA, and money which had formerly been allocated for fertilizer became available for loans to more farmers

B. Impact on ICTA as an Institution

The evaluation team believes that one of the most important outcomes of the AID project was the development of ICTA as a new institution supporting an innovative system for conducting agricultural research. AID provided assistance during a period when ICTA was defining and elaborating its role and stabilizing its program and procedures. This assistance both facilitated and hastened the strengthening of the newly established institute.

1. Improved Qualifications of Staff

The strengthening of ICTA's institutional capacity is reflected in the improved qualifications of ICTA staff. In 1970, when the agricultural research system was being assessed, 50 technicians were responsible for agricultural research throughout Guatemala. Most were peritos agronomos, high school graduates with some agricultural trade school preparation. Only 38 percent had B.S., M.S., or Ph.D. degrees.

By 1976, when the Food Productivity and Nutrition Improvement Project was approved, ICTA staff had increased to 145 technicians, 65 percent of whom had earned B.S., M.S., or Ph.D. degrees. In 1979, 76 percent of ICTA's 159 technicians had B.S. or higher degrees. This strengthening of the qualifications of ICTA personnel occurred in all technical and support units except the socioeconomic unit. Additional information on improved staffing and other institutional development factors is presented in Appendix E.

At all levels of the ICTA system, the evaluation team was impressed with the knowledge of ICTA personnel and their commitment to the ICTA system of agricultural research. During visits to 30 farms, all ICTA personnel knew and understood the farm enterprise and related well with farmers who were collaborating in research.

2. The Role of Expatriates

ICTA program leaders expressed the unanimous opinion that expatriate assistance enabled ICTA to benefit quickly from the scientific work being done outside Guatemala. Expatriate personnel were highly qualified and closely linked with international supplies of improved germ plasm. In the opinion of ICTA leaders, expatriate assistance facilitated the screening and testing of new varieties and the development of new recommended technologies.

AID-supported expatriates functioned in both management and technical positions. With their assistance, ICTA continued to develop as an organization, and research programs advanced while Guatemalans were receiving

advanced training. Under the AID project, 10 ICTA professionals (1 Ph.D. candidate and 9 M.S. candidates) were sent to universities in the United States and other countries for advanced degrees. They began returning to ICTA in 1979 and 1980 to replace expatriates.

3. Increased Governmental Support

One of the best indicators reflecting the positive results obtained from this project was the dramatic increase in financial assistance provided to ICTA. During the course of the AID project (1976-1980), the government's budget to ICTA more than doubled, from $2.3 million to $4.7 million. Such increases have resulted in the improved capacity of the technical and support units described in Appendix E. In the future, however, additional resources will be required to sustain ICTA's present system and permit its expansion. Additional numbers of highly trained professionals will be required over the next five years. At present, there is a very high attrition rate among personnel with advanced degrees, especially among M.S. and Ph.D. technicians. For example, of the seven technicians with M.S. degrees in 1976, only four remain with ICTA. The others are now employed by the private seed industry.

With the departure of expatriate advisors, high attrition rates among personnel with advanced degrees may make sustaining and expanding the present system more difficult. Higher salary levels would probably reduce the attrition rate, but ICTA has not been successful in efforts to obtain from the government the authority to revise its salary schedules and the resources to pay higher salaries. The team believes that ICTA's high attrition rates among trained personnel are a serious matter and could threaten ICTA's future.

One closing note concerns the need for more effective working relationships between ICTA and the extension organization, DIGESA. The quasi-extension activities carried out by ICTA have resulted in some confusion about the respective roles of the two organizations. Team interviews suggest that personnel in DIGESA, BANDESA, and the Ministry of Agriculture's Sectoral Planning Office do not fully appreciate the difference between ICTA's techniques of informal diffusion and DIGESA's responsibility for formal dissemination of recommended new technologies. Most extension agents interviewed lacked knowledge of the functioning of the ICTA system and were unfamiliar with specific ICTA recommendations or their benefits.

Recent developments suggest that this problem is being addressed. The credit management responsibilities of DIGESA agents have been eliminated, making extension work their principal field responsibility. ICTA has developed a comprehensive program to train DIGESA personnel in all aspects of the ICTA technology development system. The new ICTA Director, who was the former DIGESA Deputy Director, is likely to encourage greater cooperation between ICTA and DIGESA. Thus, it seems likely that new patterns of relationship between ICTA and DIGESA will eventually be worked out.

IV. CONCLUSIONS AND LESSONS LEARNED

A. Conclusions

ICTA serves as a pioneer among agricultural research institutions. It was one of the first national agricultural research institutions within the developing world to organize an innovative methodology for the generation of technology appropriate to small farm conditions. The methodology developed fits within the broad framework of farming systems research. The evaluation team concludes that within a relatively short time period, significant institutional, operational, and research accomplishments have been produced.

Under the ICTA system, significantly improved seed varieties and cultural practices acceptable to the small farmer were developed for maize, beans, and sorghum. Farmer awareness of the importance of improved seed has been so developed that a thriving seed industry has developed almost completely within the private sector. The estimated value obtained from the increased production calculated from "ICTA certified" seed is more than 2.5 times that of the total ICTA budget, and represents a considerable foreign exchange savings of funds heretofore spent on imported seed. Compared with the pre-ICTA 1970-1972 averages for maize, all ICTA collaborators record yield figures at least double earlier averages.

However, the nature of the ICTA methodology directed toward producing farmer-accepted technology caused confusion between the roles of research and extension. The ICTA approach requires the formulation of new relationships between research and extension substantially different from the past. The same type of innovative thinking needed to develop the ICTA methodology must be done for DIGESA, the extension service.

Around the world, ICTA has come to represent a new approach for agricultural research with agricultural planners and researchers studying ICTA as a model for possible replication. A structure similar to ICTA's is being proposed in Honduras. The U.S. University Consortium for International Development is sending 32 Latin American researchers to ICTA to observe the system. Cornell University has selected ICTA for a case study model for a farming system research publication.

B. Lessons Learned

The evaluation team summarizes the lessons learned from ICTA as follows:

1. "Farming system research" has been almost romanticized by some students of agricultural research. This evaluation serves as one of the first studies to bring hard data to this new topic. The ICTA approach to technology development demonstrates clearly the positive benefits derived from this unconventional approach for generating acceptable small farmer technologies and practices.

2. The ICTA project demonstrates the important role of USAID in working cooperatively with countries over a long period. During the five year pre-ICTA period, AID worked with the Government of Guatemala in planning and implementing the reorganization of the public agricultural sector. AID's early and sustained involvement in the development of ICTA helped assure that assistance was both timely and appropriate. Many of the important interactions took place outside of any specific project context in exchanges between the resident USAID Mission, AID/Washington technical staff, and Guatemalan counterparts.

3. This project demonstrates the potential that AID has for helping develop and strengthen national agricultural institutions. While assisting in the design phase of ICTA, AID was able to call on U.S. research experience, its earlier institutional development work in Guatemala, and the varied experiences of the international agricultural research centers of which it is the largest supporter. Collaboration with other donors such as the Inter-American Development Bank and the Rockefeller Foundation were also important. AID's capability for effectively utilizing the resources of other donors to augment the work of national-level programs is well illustrated by the ICTA experience.

4. This project demonstrates the importance of investing simultaneously in human, institutional, and technological resources and the comparative advantage AID has in institutional development work. One of the most important outcomes of the project was the development of ICTA as an institution supporting an innovative system appropriate to small farmer needs. The project provided assistance during a period when ICTA was defining its role and stabilizing its program and procedures. With expatriate assistance, ICTA was able to develop an organization and advance its research programs while Guatemalans were receiving advanced training.

5. The ICTA experience shows a need in institution-building projects to develop linkages that provide the resources and authority that the institution needs to continue. This component, if neglected, threatens the success of the entire enterprise.

6. ICTA's links to international agricultural research centers and to U.S. centers of technology expertise were highly productive. Technologies and concepts from these centers were applied in Guatemala, and through these same centers the Gautemalan experience is coming to the attention of other countries around the world. Both AID as an Agency and its Missions within each country should be aware of the capabilities of research centers and consider ways to make of these resources in future research and development efforts.

7. Responding to the multiple-cropping systems employed on most small farm enterprises, the ICTA project documents the important role interdisciplinary technological and sociological coordination plays within small farmer agricultural research projects.

8. The high attrition rate of ICTA's advanced degree scientists is a concern to many developing country research institutes. The present

government salary structure has no ready means of addressing this problem. Given the proven macroeconomic benefits ICTA provides to Guatemala's predominantly agricultural society, special financial incentive arrangements to retain this needed scientific expertise should be considered.

9. The project demonstrates that to assure small farmer participation in the development process, special programs need to be developed and information feedback systems employed to test technology results. When such systems are in place, the ICTA experience shows that small farmers will assess the merits of the technology and gradually adopt it.

10. This project demonstrates the essential need for flexibility in the implementation of a project. The project as designed on paper bore little resemblance to the implemented project, which was flexible enough to reorient resources to changed circumstances and priorities in a way that produced effective results.

APPENDIX A

EVALUATION METHODOLOGY

During a three-week period in May 1980, the evaluation team visited the AID Mission in Guatemala City and three regions in which ICTA was working. The team leader was familiar with the background and development of the project. A second team member, an agricultural development officer, had no previous direct experience with ICTA or the project. Marc Antonio Martinez, of ICTA's socioeconomic section, escorted the team to each of the three regions.

The regions chosen for evaluation were the first three in which ICTA had worked. These regions--La Maquina on the coast, Quetzaltenango in the highlands, and El Oriente in the dry interior--differ markedly in geographical characteristics and have had the longest possible experience with ICTA as a new organization.

The team visited the Production Centers in each region, spending approximately two days at each location. Meetings were held with the regional directors of ICTA, DIGESA, and BANDESA, with ICTA production team leaders, commodity team personnel, expatriate advisers, and with ICTA field personnel. All expatriate advisers and about half of all ICTA field personnel were interviewed. In each region, several DIGESA and BANDESA field personnel were also interviewed.

Meetings with individuals were generally held on the first day at each Production Center. On the second day, team members dispersed for visits to ICTA's on-farm research and testing sites. Working separately, team members interviewed on a random basis a total of 30 farmers who were collaborating with ICTA and farmers living in the same area to determine knowledge and acceptance of ICTA technology. Additional time was spent in Guatemala City consulting with AID Mission staff and reviewing the data collected.

APPENDIX B

ICTA APPROACH TO TECHNOLOGY DEVELOPMENT

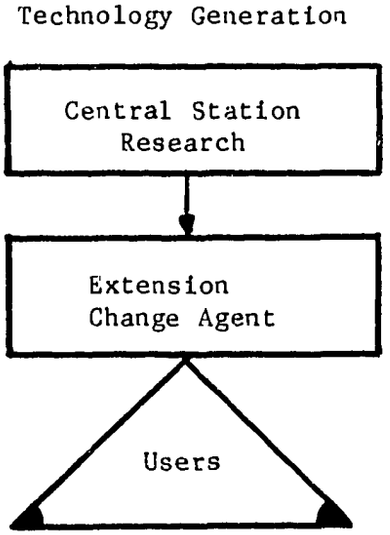
I. Introduction

ICTA was one of the first national agricultural research institutions to develop a methodology and structure for generating technology appropriate to the agro-ecological, agro-economical, and social conditions of the small farmer. The methodological system has been acclaimed to be one of the best of its type.* The purpose of this appendix is to describe one of the more relevant though least measurable of the ICTA project "impacts": the development of a technology development system responsive to the needs of the small farmer.

II. Traditional Approach to Technology Development/Transfer

Over the years the generation and transfer of agricultural technology has traditionally been conducted from a dichotomous institutional structure. The scientific researcher assigned to a central research station has developed "recommendations" for the extension agent to disseminate to the awaiting farmer. An illustration of this top-down, unidirectional technology flow is depicted below.

Chart B-1. Traditional Model for Technology Development



* Michigan State University's D. D. Harpstead wrote, "ICTA's objectives are aimed at generating technology and providing assistance in increasing the production income and general welfare of the small scale farmer of Guatemala. In this task, ICTA's philosophies, approaches, and procedures are unsurpassed in the developing world."

Though in certain countries this model has worked, particularly for the well-endowed farmer, the small farmer has not been a significant beneficiary of new technology. Universally, research station yields were double and triple those of the small farms. The accounts of green revolution technology adoption have demonstrated that new technology was not neutral in scale. The traditional approach seldom accounted for the constraints of the small farmer. Consequently, to assure small farmer adoption, technology more appropriate to the problems and resources of that group must be developed. The following comments deal with the reasons why traditional approaches have not always provided broadly accepted technology for the small producer.

A. Research

-- The "biological architect" has conducted research work under controlled and optimum conditions. Seldom were farmer conditions used as the reference point for generating technology. The scientist usually was unaware of the myriad of constraints affecting the small farmer and tended to view farmers as a homogenous lot. The complex factors related to risk aversion, climate, soil, off-farm employment opportunities, family labor constraints, and local cultural practices were seldom studied.

-- Research was not directed to the specific problems of the small farmer but rather to increasing yield per land unit. Profitability improvement, rather than strict yield maximization which usually requires more capital intensive technology, is a principal factor for small farmer new technology acceptance.

-- Research recommendations were usually site specific to the station and had little relation to soil and climate variations on a wide geographic area and particularly to the adverse conditions of the upland small farmer.

-- Seldom were social science skills included within the research staff.

-- Seldom were followup farmer evaluations conducted.

B. Extension

-- Since researchers did not develop their findings based on farmer needs and realities, the extensionists' confidence in the new recommendations was low. The extensionists, consequently, were continually in a state of confusion or misunderstanding both in their work with the user and in the generation of new technology.

-- The "better educated" researcher was often viewed by the extensionists as being too sophisticated in approach. This impression was compounded through the researchers' distance from farm realities.

-- The traditional system assumed ready farmer acceptance if the extensionist could only "persuade" the small farmer. The system did not

consider that other supporting services (for example, credit or marketing) along with profitable price relationships had to be made available if new technology was to be adopted.

III. Restructuring the Agricultural Sector

In the late 1960s the government undertook a major assessment of rural Guatemala. Among the many findings, it was observed that food production was not keeping pace with local demand and that the income levels of rural residents were declining. To redress this situation, the 1971-1975 Rural Development Plan identified the small farmers as the focus for a policy to increase employment and income levels. Basic grains production, the traditional crops of the small farmer, was to be emphasized. Diversification, where feasible, into more remunerative crops was also encouraged.

To help facilitate this impetus toward economic development centered on the small farmer, a major reorganization of the public agriculture sector was undertaken. (See Chart B-2.) The Ministry of Agriculture was restructured to permit the Minister to be the principal coordinator ("rector") of the agriculture sector. A series of new support agencies (most of which would be autonomous) directed to technology development (ICTA), extension (DIGESA), credit (BANDESA), marketing (INDECA), and forestry (INAFLOR) were established. ICTA's resposibility was to "develop technology and promote its use for the well being of the population." It was not to concern itself with science, but to have a technology "promotable" for the rural traditional sector. In effect, ICTA was charged with bridging the gap between technology generation and transfer and farmer acceptance. Extension responsibilities were delegated to DIGESA. Guatemala was divided into regions and a regional coordination of services was instituted.

IV. ICTA Organization

The ICTA charter provided it with a certain administrative flexibility regarding administration, purchasing, salary levels, hiring, contracting, and program budget. Expatriate advisors were given power to function temporarily in a managerial capacity in various line positions. In addition, the charter provided encouragement to take full advantage of the work being done at the international agricultural centers and foreign universities.*

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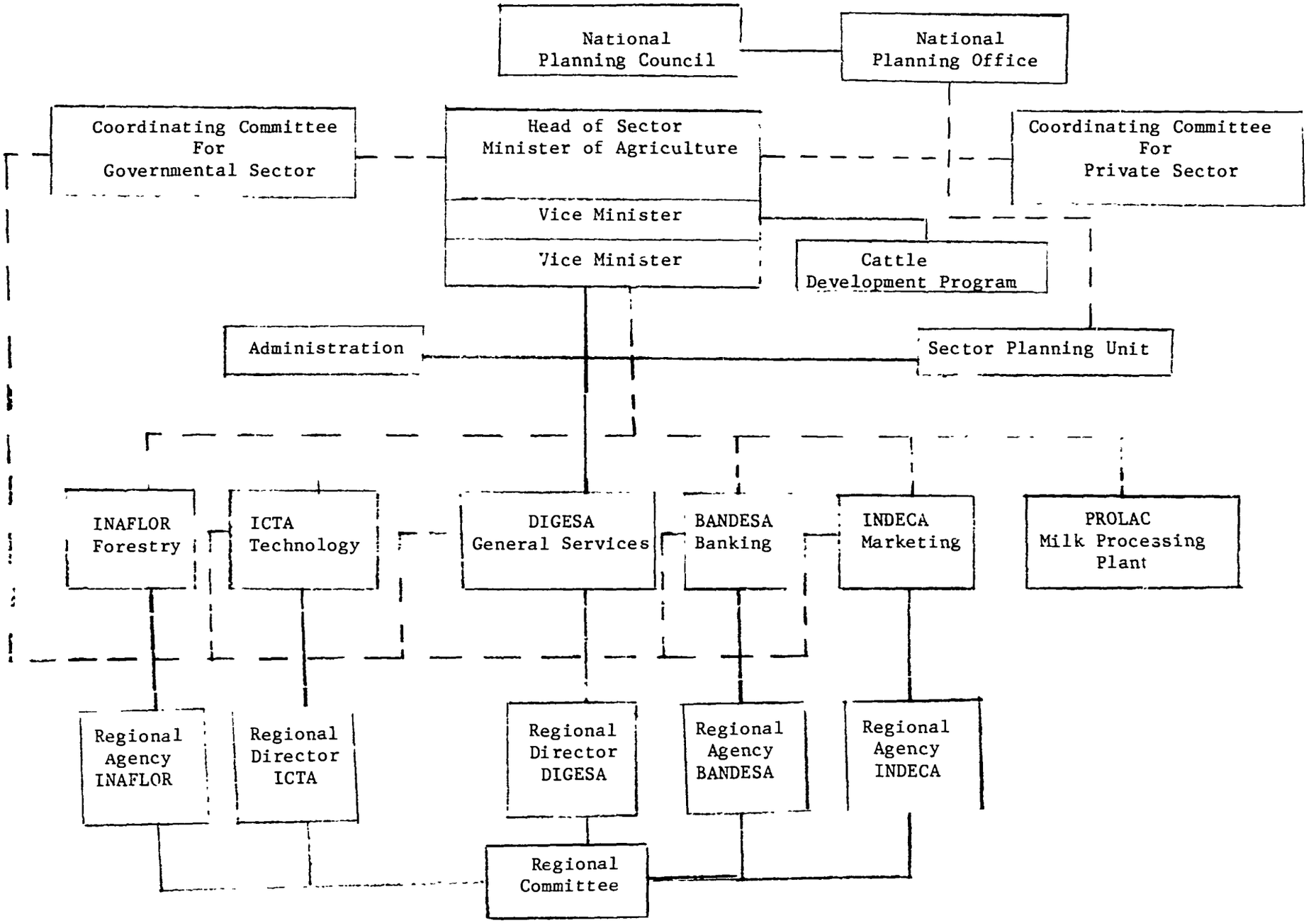
*In this regard the team observed the close ties with CIAT, CIMMYT, CIP, and Texas A & M University, and the positive benefits to the institutions through this arrangement. The international centers need strong national centers which can do adaptive tests and screening.

Chart B-2: PUBLIC AGRICULTURAL SECTOR (PAS)



Organizationally, the ICTA structure was simplified through the creation of three units, an Administrative and Financial Service Unit, a Program Unit, and A Technical Unit for Production. The Technical Unit for Production was the unit of most interest to this study. Within this unit a commodity program focus was integrated with across-the-board socioeconomic, technology validation, soil management, and training support functions along with the technical services groups for experimentation, seed processing plants, soils laboratory analysis, and publications services. Commodity, support, and service groups were coordinated at the national level. All support offices were directed either by expatriate scientists or Guatemalans, most of whom had at least an M.S. degree. This unit provided orientation and technical support to the regional levels.

At the regional level, controlled research activities were conducted at a "production center" whose activities were closely linked with farm problems and farm trials. Although the ICTA system required decentralization of authority, it also required a national level technical support capacity. The regional director was responsible for coordinating a team that included representatives from the national level commodity program and from the technology validation group. These team members were responsible for regional research and data collection, analysis, and report preparation, respectively.

V. ICTA System

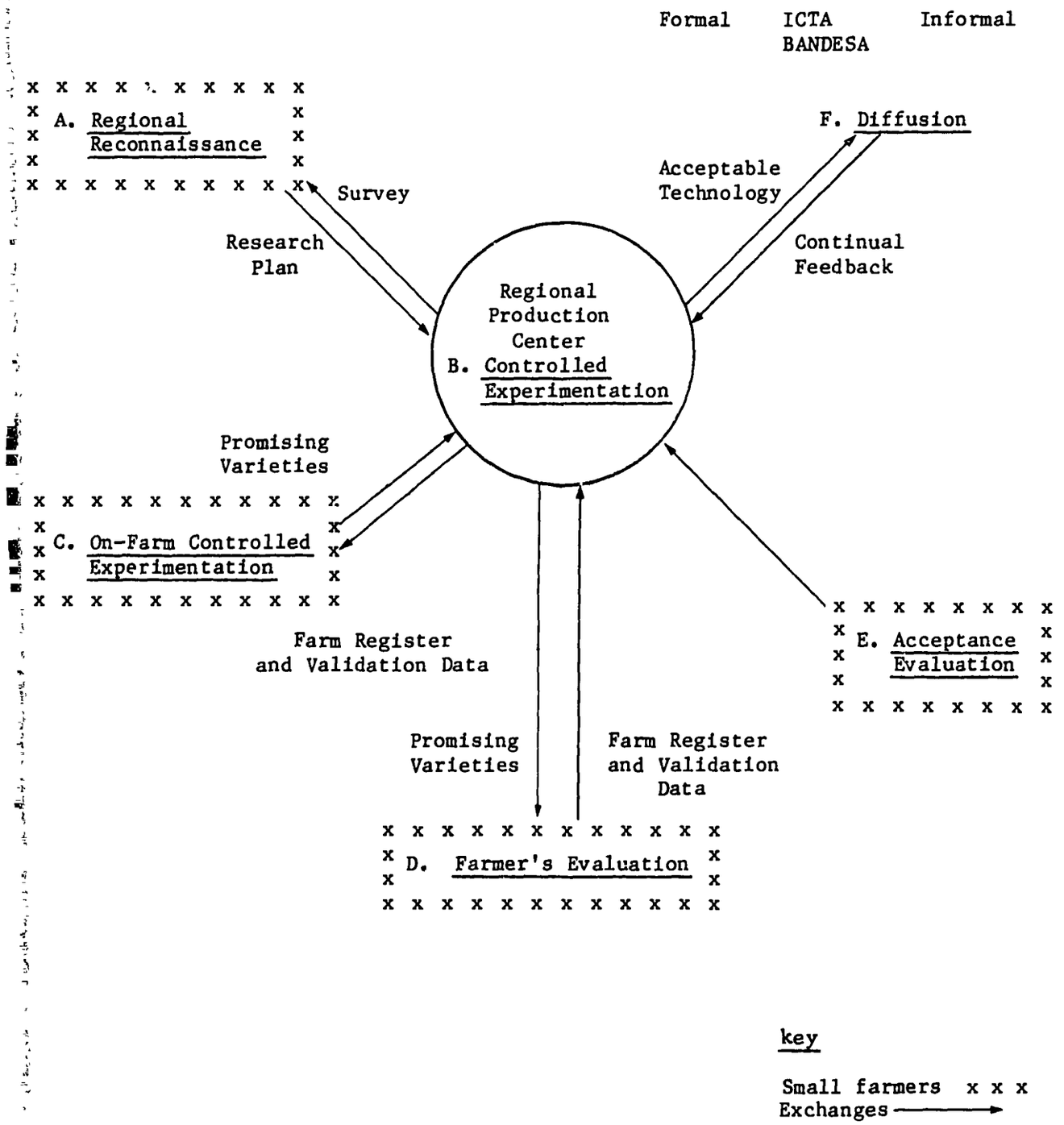
ICTA has developed a system directed toward reducing the negative aspects of traditional agricultural research. An effort was made to bridge the gap between technology generation and transfer by establishing a closer linkage with the farmer. The ICTA system establishes research priorities based on farmer needs, conducts most of its testing at the farm level, and conducts field studies to determine farmers' costs and acceptance associated with each recommendation. The process of screening technology through collaborating farmers produces a series of recommendations proven to be both acceptable and profitable for the small farmer.

The series of interrelated events developed to institutionalize farmer/research collaboration are sketched in Chart B-3. In practice, this wheel depiction of the ICTA is a never-ending continuum of activities. The emphasis is on understanding the farmer's system and ICTA interacting with this system. A discussion of these various activities in sequential order is presented in the following section.

A. Reconnaisance--Socioeconomic Survey

Research plans are not established at national headquarters but are developed regionally. In developing these plans, farmers' needs and practices and the technologies available are taken into consideration.

Chart B-4. The ICTA Process



Prior to the preparation of the plan, a reconnaissance study is conducted by a multidisciplinary team. First, all available data relating to climate, production activities, soil, population, and other relevant factors are obtained. Then, several teams consisting of one agricultural scientist and one social scientist are formed. During a two-week period, these teams visit as many farmers as possible, examining traditional practices employed, land tenure relationships, cropping activities, yield patterns, the availability of labor, and many other factors. At the end of each day of farm visits, the results are reviewed and team members rotate. After two weeks, all results are jointly analyzed and a report describing the economic conditions is prepared. This report serves as the basis for identifying problems and developing a research plan.

In subsequent years, the report is revised as ICTA personnel work closely with farmers and obtain additional data.

B. Production Centers--Controlled Experimentation

An annual regional research plan is prepared jointly by regional production teams and national commodity program personnel. The plan is prepared with research priorities directed toward immediate or intermediate application to the problems identified. Some controlled research takes place at the regional production center. According to all the researchers consulted, such controlled research cannot be bypassed. Nonexploratory research directed for immediate application, such as evaluation of germ plasm provided from an international center, is conducted. At this level, commodity program scientists conduct their research. Germ plasm and other technology which passes the production center screening move to on-farm experimentation, and even some of the original screening is being done on the farm.

C. On-Farm Controlled Experimentation

To provide a technical field evaluation of the more promising production center findings and to assess farmers' interest, controlled experimentation is conducted on farms. ICTA believes that the scientific work must be controlled and evaluated by scientists who have become knowledgeable of farmer practices. In the 30 plots visited, none of the farmers had more than five manzanas of farm land. A member of the technology validation unit conducts these tests. ICTA supplies the necessary inputs and technical supervision, while the farmer is encouraged to collaborate. The collaborator receives the harvest. The new technology is always compared with the traditional practices as a control. The research work is conducted with experimental design so the technician can prepare various statistical analyses of these results and makes comparisons with the control crop. Results of these analyses are used by ICTA for planning subsequent activity. Only about 20 percent of ICTA's work is done on the production center. Over the last few years, from 800 to 1,000 farmers per year have participated in farm level research and testing.

D. Farmer's Evaluation--On-Farm Testing

Innovations surviving the ever-narrowing screening process must undergo a final test under the farmer's multicropping conditions. The purpose of this test is to observe how the new technology is actually administered by the farmer on a small portion of his land and to get his opinions as to appropriateness. There is virtually no ICTA control in on-farm testing. Only that technology which ICTA believes is a definite improvement enters this phase. The collaborating farmer is expected to provide his own inputs, but if the prescribed inputs are not available, ICTA will "lend" them with reimbursement provided after harvest marketing. To avoid overwhelming farmers with too many recommendations, no more than three new practices are tested simultaneously. As in the farm experimentation, a comparison of the ICTA technology with traditional technology is made.

During both the farm experimentation and farmer evaluation steps, one technology validation technician is required to work with 10 collaborators in the maintenance of daily farm trial registers. Simple sheets are used to record both family and off-farm labor requirements (wage rate for both included), appropriate input applications data, cultural practices employed, and yield and income data. Weekly, monthly, and cropping cycle analyses of these data are made using specially designed programs written for handheld calculators. Since 1975, when 40 collaborators were participating each year, the number of registers maintained has more than doubled. Each register is reviewed with the collaborator. In each region visited some of the farmer collaborators had independently incorporated this system or had developed a similar system to prepare them for better farm management decisions.

E. Acceptance Evaluation

With completion of the farmer evaluation stage, the most important issue now confronting ICTA is the determination of what recommendations the farmer will accept on his own. Before the formal diffusion process is initiated with DIGESA and BANDESA, ICTA makes a determination of technology acceptance by the collaborating farmer. During the first cropping cycle after the farmer's evaluation, the collaborating farmer is visited by ICTA socioeconomic personnel to determine the degree of farmer acceptance and the extent of land devoted to the recommendation. An Acceptance Index (AI) is calculated to represent the percentage of joiners within a region who are using a new practice multiplied by the percentage of the land on which they used it. In discussions with farmers, explanations for the rate of acceptance are recorded. If the AI for a particular recommendation is above 50, a fairly strict test, it is considered ready for DIGESA diffusion. If the AI is below 50, additional testing is required. AI clearly supports the view that farmers are the ultimate evaluators of technology. Appendix D reviews AI data obtained in two regions.

In concluding this discussion of the ICTA technology generation process, it is appropriate to observe that all expatriate research scientists, who were accustomed to working in conventional systems, respect the ICTA system and enjoy working in it.

F. Diffusion

Although the ICTA system generates technology with a proven relevance for small farm systems, a formal system for technology diffusion must be developed for massive small farmer application. ICTA's interaction with the farmer, particularly through the periodic field days, provides for an informal technology diffusion system. Through the ICTA system, it is estimated that 20,000 farmers have been exposed to the new technology. However, there has been some confusion regarding the roles of ICTA and DIGESA. The ICTA system is not an extension program but does use some extension techniques in its research methodology.

The impact of the ICTA system will be limited until an improved technology diffusion system for the small farmer has been developed. The team is left with an uneasy dilemma. The institutionalization of an innovative technology development system generating appropriate technology has not been maximized because of the absence of a similar system for technology diffusion. Our impressions from extensive field sessions with DIGESA and BANDESA "change agents" were that although there were some truly dedicated agents, deficiencies remained. For example, most extension agents did not possess much knowledge of (1) the economic benefits derived from new technology application, (2) how the ICTA technology development system functioned, or (3) specific ICTA recommendations.

A comprehensive system capable of diffusing the ICTA recommendations is needed. This same observation has been reported in all annual project evaluations.

In this regard, we did observe a few positive signs indicating that the government was trying to address this problem. For example, the Quetzaltenango Regional Agriculture Sector Coordination Unit, CORDECA, had just institutionalized a coordination of service program exercises based on participating agency priorities. ICTA and DIGESA had selected technology transfer as the priority topic, as had other agencies. Specific activities supportive of this priority, which included monthly progress evaluation, were being developed. Other examples of an improved technology transfer process include: (1) greater ICTA/DIGESA coordination based on the recent naming of the previous DIGESA Deputy Director as the new ICTA Director; (2) the decision to remove DIGESA from its prior BANDESA credit management responsibilities, thus making extension work DIGESA's principal field responsibility; and (3) the comprehensive training program ICTA had developed for training DIGESA personnel on all aspects of the ICTA technology development system.

APPENDIX C

THE ROLE OF IMPROVED SEED

Improved seed offers several advantages in technology. It is a package of improved technology (genetic technology) that is relatively easy to deliver because farmers are always looking for improved seed. Furthermore, it is easy for farmers to make their own test of this innovation and to adopt it without changing any other farming practices. Improved seed can often provide a profit incentive to change other farming practices and thus may become the first in a series of innovations. Once introduced, improved seed tends to persist. Farmers can save their own seed and can sell it to others. Given the widespread importance of crops, even small improvements make big differences when applied to total acreage. Seed is also relatively easy to merchandise. Growers, processors, and merchants can sell seed for their own profit, minimizing the need for investments of public resources.

ICTA is exploiting all of these advantages. With the help of the international research centers, it is developing and testing improved germ plasm. For some commodities the improvement seems dramatic. Through its style of on-farm testing, farmers can observe the new seed and sometimes start its diffusion even before ICTA is satisfied with its testing. The evaluation team visited four farmers who were using an improved variety of beans that they had seen in a local on-farm test. They had bought the seed from the farmer before its official release by ICTA.

ICTA works with several commodities--wheat, rice, sesame, maize, beans, and sorghum--but the USAID contract addressed only the last three, providing about five years of assistance in each. In all three cases, the assistance was supplied under contract by international entities with both expertise and a worldwide collection of germ plasm. CIMMYT provided two maize breeders, CIAT provided two bean breeders, and Texas A & M University provided a sorghum breeder. (ICTA also worked with CIMMYT on wheat and with CIAT on rice using IRRI genetic material, but these were not under the USAID contract.)

After developing and testing, ICTA releases improved varieties of seed to private growers who multiply them under ICTA supervision to maintain both genetic purity and freedom from weed contamination. ICTA provides processing and storage facilities to the commercial growers for a fee, and the first generation seed is released with the label "ICTA certified." Second generation seed is now being sold under brand names that associate it with ICTA, suggesting that the public has confidence in ICTA seed.

Using ICTA data on the supervised production of "ICTA certified" seed, the evaluation team attempted to estimate its impact on Guatemalan agriculture. Tables C-1, C-2, and C-3 present data for five crops. Since only maize and beans were supported by AID project funds, the following discussion of the tables focuses on these two crops.

Table C-1 describes the estimated amount of "ICTA certified" seed available from growers in 1978. Twenty-three growers produced maize seed, using 583 manzanas of land, while only two growers produced bean seed, using

Table C-1. Estimated Amount of "Icta Certified" Seed Available From Growers, 1978*

Crop	Number of Growers	Area of Seed Production mz**	Average Seed Production cwt/mz***	Estimated Amount of "ICTA Certified" Seed Available cwt
Maize	23	583	30	17,490
Beans	2	17	15	255
Rice	7	120	75	9,000
Wheat	4	43	35	1,505
Sesame	4	45	12	540

* Not all of the seed developed by ICTA is included in these calculations, because some companies and associations produce seed outside the ICTA system.

** mz = manzana = 0.7 hectares = approximately 1.5 acres.

*** cwt = hundredweight

Source: ICTA. Calculations made by the authors.

Table C-2. Estimated Increased Production of Five Crops Resulting From Production of "ICTA Certified" Seed, 1978*

Crop	Estimated Amount of "ICTA Certified" Seed Available cwt**	Seed Needed For Planting cwt/mz***	Estimated Farm Areas Planted mz	Increased Yield**** cwt/mz	Estimated Increase in Crop Production cwt
Maize	17,490	0.25	69,840	15	1,047,600
Beans	255	0.75	320	5	1,600
Rice	9,000	1.00	9,000	20	180,000
Wheat	1,505	1.60	940	18	17,920
Sesame	540	0.06	9,000	4	36,000

* Not all of the seed developed by ICTA is included in these calculations, because some companies and associations produce seed outside the ICTA system.

** cwt = hundredweight

*** mz = manzana = 0.7 hectares = approximately 1.5 acres.

**** Increased yields obtained over traditional unimproved varieties.

Source: ICTA. Calculations made by the authors.

Table C-3. Estimated Value of Increased Production Resulting From Production of "ICTA Certified" Seed, 1978*

Crop	Estimated Increase in Crop Production cwt**	Price $/cwt***	Estimated Value of Increased Production $
Maize	1,047,600	7.00	7,333,200
Beans	1,600	20.00	32,000
Rice	180,000	10.00	1,800,000
Wheat	17,920	11.50	206,080
Sesame	36,000	25.00	900,000
Total			10,271,280

* Not all of the seed developed by ICTA is included in these calculations, because some companies and associations produce seed outside the ICTA system.

** cwt = hundredweight

*** The Guatemalan quetzal is equal to one dollar. Price used is quoted from ICTA bulletins.

Source: ICTA. Calculations made by the authors.

17 manzanas of land. By multiplying average seed production per manzana by the area devoted to seed production, the estimated amount of "ICTA certified" seed available can be calculated--an estimated 17,490 hundredweight of maize and an estimated 255 hundredweight of beans.

Using these estimates, Table C-2 develops estimates of increased production resulting from this seed. Estimates of farm areas planted are derived from estimates of the amount of seed available and information on amount of seed needed for planting one manzana. Then, using data on increased yields obtained from "ICTA certified" seed, increased crop production is estimated--more than 1 million hundredweight of maize and 1,600 hundredweight of beans.

Table C-3 estimates the value of this increase in crop production, using prices quoted in ICTA bulletins. For maize, the value is estimated to be more than $7 million; for beans, the value is estimated to be approximately $32,000. For all five crops presented, the total value of increased production is estimated to be more than $10 million.

Considering that the total ICTA budget in 1979 was only $4 million, this estimated impact on Guatemalan agriculture is indeed impressive. In one respect, the estimate may overstate the case. The figures used to represent increased yield refer to increases obtained over the traditional, unimproved seed. Perhaps not all of the "ICTA certified" seed is replacing that quality of seed. Nevertheless, to some extent the calculated value is underestimated because it does not include either ICTA genetic material that is produced independently or second generation ICTA seed that is sold on a commercial scale without ICTA supervision. As seed quality improves and seed production increases, even greater impacts may be expected.

APPENDIX D

ACCEPTANCE OF ICTA TECHNOLOGY

I. Introduction

As reported in Appendix B, ICTA attempts to measure farmer acceptance during the first cropping cycle after farmers collaborate in the on-farm testing of ICTA recommendations by sending ICTA personnel to determine what recommendations, if any, farmers have adopted voluntarily. For each region, an Acceptance Index (AI) is calculated; the percentage of collaborators continuing to use the recommended technology is multiplied by the percentage of land they are using it on. Fifty has been established as the AI required before ICTA considers its recommendations to be ready for diffusion to large numbers of farmers. This is a stringent test; all farmers could be using the recommended technology and the AI could still be less than 50.

Since Acceptance Indices measure acceptance only during the first year after on-farm tests, they may underrepresent the eventual acceptance in new recommendations by conservative farmers. Also, by focusing exclusively on ICTA collaborators, the Acceptance Indices permit no inferences to be drawn regarding mass acceptance. In spite of the limitations, the AI offers the only overall impression available of the acceptance of ICTA technologies by collaborating farmers.

To reflect some of the differences and complexities encountered in developing acceptable technologies for small farmers, the evaluation team examined AI data for two dissimilar regions. Since maize is the principal crop of the small farmer in Guatemala, only that crop will be discussed.

II. The Highlands--Totonicapan

A. The Setting

In the central highlands of Guatemala, large numbers of small farmers work on small fragmented farms. The average total area cultivated by each farmer is only 0.6 hectares. Most of the land is intercropped in the traditional milpa (maize, beans, and horse beans) developed by their Mayan ancestors. The most important crop is maize. Conservatism has hindered the rapid introduction of improved maize seed. Many farmers take great pride in their criollo (native) seed that has been passed from generation to generation. Some farmers feel so strongly about their seed that they refuse to follow ICTA recommendations for thinning maize seedlings because this would "kill" the remaining plants.

Only 20 percent of farmers depend exclusively on their own farm for their livelihood. Farming activities are carried on primarily for subsistence. Except for the extensive use of chemical fertilizers, "modern" farm practices were not widely practiced when ICTA began working in the region.

B. ICTA Recommendations and Their Acceptance

In 1975, nine recommendations were introduced for testing; all were modified as a result of farmers' evaluations and AI feedback. By 1979, ICTA's recommendations had been reduced to five. Table D-1 compares traditional practices with ICTA recommendations.

Table D-1. Comparison of Traditional Practices, 1977, and ICTA Recommendations, 1979, for Maize in the Totonicapan Area

Treatment	Traditional Practices	ICTA Recommendations
Seed varieties	criollo	San Marceno
Seed density	6.5 per mound	4 per mound
Distance between rows	1 meter	1 meter
Planting distances	1 meter	.6 meters
Thinning lower leaves	constant	not necessary
Fertilizer applications	1 application of 16-20-0, 150 lbs/mz	2 applications of 20-20-0, total of 80-90 lbs/mz

Source: ICTA reconnaissance survey, 1977, and ICTA records, 1979.

Table D-2 presents Acceptance Indices for each ICTA recommendation over a five-year period. Since the recommendations were made with a changing group of collaborating farmers and were being modified during this five-year period, they must be interpreted with care. The data presented show yearly fluctuations and limited consistency. Only seed density and fertilizer recommendations had indices approaching or exceeding 50 in 1979.

The AI can lead to misleading interpretations. If recommendations are accepted gradually over a period of time, this will not be reflected in the AI. Apparently, that is what has happened in Totonicapan. Although the San Marceno variety of maize will bring substantially increased yields, it has not been accepted rapidly because of the strong tradition associated with traditional seed.

Table D-2. Acceptance Indices for ICTA Recommendations for Maize, Totonicapan, 1975-1979

ICTA Recommendations	Year				
	1975	1976	1977	1978	1979
Varieties	4	54	19	23	20
Seed density	10	64	30	30	50
Planting distances	7	4	13	44	17
Fertilizer, first application	0	0	0	6	73
Fertilizer, second application	21	4	4	69	43
Yearly average	8.4	25.2	13.2	34.4	40.6

Source: ICTA

When adoption alone is examined (without regard to the percentage of land involved) a different picture emerges. Table D-3 presents the percentage of collaborators voluntarily adopting ICTA's recommendations (although possibly on a small area) in 1975 and 1980. The data clearly reveal an overall increase in the percentage of collaborators adopting ICTA recommendations. An average of 40 percent more collaborators adopted ICTA recommendations in 1980 than in 1975.

C. Farm Visits

This more positive impression concerning adoption of ICTA recommendations was reinforced by collaborators who met with the AID evaluation team.

A dramatic example of rapid technology diffusion was described by a former ICTA collaborator who is also the president of a 200-member cooperative. During the first year after collaborating with ICTA (at the time the AI was being calculated), he was using ICTA's San Marceno seed on less than half of his land. The following year, however, he planted his entire farm with San Marceno. At the same time, the cooperative purchased 400 pounds of ICTA seed. Only 25 pounds remained unplanted at the time of the team's visit.

Table D-3. Percentage of Totonicapan Collaborators Adopting ICTA Recommendations in 1975 and 1980

ICTA Recommendation	Percentage of Collaborators Adopting 1975	1980
Varieties	12	59
Seed density	25	40
Planting distances	0	46
Seedling thinning	18	17
Fertilizer, first application	6	73
Fertilizer, second application	6	73
Average for all recommendations	11	51

Source: ICTA

III. Coastal Area--La Maquina

A. The Setting

The La Maquina area consists of a former hacienda that was subdivided 20 years ago into about 1,400 farms each with 20 hectares. Distribution was made to farmers, most of whom came from the highlands. This experience in pioneering may make farmers in this area more inclined to adopt new recommendations rapidly. The principal crop is maize with many of the farmers planting sesame and rice during the two growing seasons. Rainfall is unpredictable, although the area is considered humid, not semiarid. During peak periods, extra labor is contracted, usually people from the highlands. Both DIGESA and BANDESA have offices within the settlement.

Although the emphasis is on small commercial farming, the ICTA reconnaissance study revealed that only 3 percent of the area was planted in improved varieties of maize seed. Insects caused severe problems, yet the use of pesticides and herbicides was limited. A majority of farmers did, however, use chemical fertilizers.

B. ICTA Recommendations and Their Acceptance

ICTA recommendations for La Maquina focused on insect control, the use of improved seed, the elimination of fertilizer applications, and advice on other practices such as soil preparation and seeding distances.

The recommendation that fertilizer be eliminated grew out of ICTA's analysis of the collaborators' economic registers in 1976. Results showed that the use of fertilizer did not increase yields significantly. Rather, using fertilizer increased production costs by 38 percent, thereby reducing profitability by 29 percent. These findings were shared with BANDESA which at that time was requiring the application of fertilizer on farms receiving credit. BANDESA eliminated the fertilizer requirement.

Table D-4 presents Acceptance Indices for four ICTA recommendations over a five-year period. For the seed varieties and seeding distances recommendations, acceptance increased gradually. For the weed control and insecticide recommendations, an overall increase in acceptance is recorded.

Table D-4. Acceptance Indices for ICTA Recommendations for Maize, La Maquina 1975-1979

ICTA Recommendations	Year				
	1975	1976	1977	1978	1979
Seed varieties	47	53	61	71	69
Seeding distances	16	28	36	54	52
Weed control	19	38	12	11	31
Insecticide	36	59	70	66	56
Yearly average	29.5	44.5	44.8	50.5	52

Source: ICTA

C. Field Visits

Of particular interest has been the acceptance of improved seeds. In 1976, a majority of farmers planted criollo seed. By 1980, 95 percent of the farmers were using ICTA's improved varieties, according to sales

personnel who provided supplies to local farmers. Field visits corroborated this high acceptance of seed and the other ICTA recommendations described in Table D-4. On all farm visits except one, those recommendations that had high AIs were being utilized.

One farmer reported putting 50 percent of his land into ICTA seed the year after he was introduced to it, and almost 100 percent into ICTA seed the following year. The average yield increase he attributes to ICTA technology is between 44 and 50 lb per cuerda. Recently, he has purchased five silos. All of his neighbors have since adopted ICTA's recommendations.

One of his neighbors, however, chose to accept only one of ICTA's recommendations. A 71-year-old farmer, who had divided part of his land for the use of his four sons, learned of the recommended planting distances through DIGESA agents. By incorporating only this recommendation, yields had increased from five to eight bags of grain per cuerdo.

Several years previously, the farmer had tried ICTA seed on a small area, but because of a dry growing season had lost most of his crop. Consequently, he chose to retain his criollo seed. In talking further with this farmer, the evaluation team observed his high reverence for God's control (Dios manda toda) over the "santa tierra" and related reluctance to take on any risk or debt. His criollo seed and ICTA planting recommendations apparently provide him with what he feels is sufficient.

D. Conclusion

Based on a variety of analytical techniques and field visits, we are satisfied that there is a high rate of acceptance of ICTA technology by small farmers. Not only was "acceptance" recorded but in our visits with over 10 farmers in each of the three areas visited, all farmers could explain in detail what the new technology was and why it was better than what they had earlier used. The technology required less seed and fertilizer than that traditionally used. Though it was impossible to measure economic impact, all farmers visited spoke of the increased yields they attributed to ICTA technology. Compared with the pre-ICTA 1970-1972 average yield of 16.2 quintals per manzana, all ICTA records with collaborators showed yields at least doubling this and in the Jatiapa Region, yields more than four times the early average were recorded.

APPENDIX E

INSTITUTIONAL DEVELOPMENT

I. Introduction

One of the project's most important outcomes is establishment of an institutional capacity capable of supporting the ICTA technology development system described in Appendix B. This was one of the principal project purposes.*

The team believes purpose compliance was attained because of:

1. Government selection of high quality management and technical personnel who understand and are committed to applying the concepts of the appropriate technology development system

2. Use of competent scientific and management expatriate personnel

3. Selection and efficient phasing of advanced degree programs for ICTA professionals

4. Government budgetary support

5. Development of inservice training programs

The aim of this appendix is to describe the AID project's institution building activities.**

II. Pre-ICTA Agricultural Research Institutional Structure

Guatemala agricultural research in 1970 had a small staff of trained personnel receiving limited budget support. In 1969, the Division de Investigacion Agropecuaria of the Ministry of Agriculture, the largest government agricultural research structure, consisted of but 50 technicians, most of whom were trade school agriculturalists, 2 Ph.D.'s, 10 M.S.'s, 7 B.S.'s, and 31 P.A.'s (perito agronomos--high school graduates with some agricultural trade-school preparation). Their annual research budget was $400,000. No

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* The original Project Paper explains that one of the stated purposes was to "Improve the Government of Guatemala's capability to develop, screen, and to introduce new and/or improved seed varieties, cultural practices and crop mixes while putting presently available improved farming techniques into practice."

** As earlier discussed, the Rockefeller Foundation played a major role in this process. Other donor assistance was provided by the Inter-American Development Bank and the Taiwan Horticulture Advisory Team.

system had been developed to evaluate the results of their new technology at farm level.*

As mentioned in Appendix B pursuant to the agricultural assessment, the importance of increased attention to small farmer development was identified, and a comprehensive organizational structure was developed. As stated in the national rural development plan, agricultural technology development was to be revitalized. In support of this initiative, both the Rockefeller Foundation and AID performed principal institution-building roles.

III. Institution Building

We were impressed with the number and quality of professionals observed on all levels of the ICTA system. At the field level, all personnel whom we met related well with their collaborators and knew and understood the farm enterprise and its problems. Each knew the other on a first-name basis. We were also impressed with the knowledge that ICTA personnel had on the various steps in their system and their commitment to that system. Non-ICTA personnel working in other Ministry of Agriculture offices were of the opinion that within the agricultural sector, ICTA had the best personnel. These are all important outcomes of the institution-building process. Four factors which we believe are responsible in varying degrees for these positive observations relate to technical assistance, graduate level training, government budget, and inservice training.

A. AID Technical Assistance

As observed earlier, the capacity of the pre-ICTA research structure to implement the process of technological change defined in the Rural Development Plan was weak. Accordingly, it was decided that the quickest means to get research moving would be the contracting of expatriate expertise. The ICTA legislation reflected this observation, for it permitted the assignment of expatriate personnel to operational line management and technical positions. It was believed that from these positions, greater impact in program design and execution could be made. The Rockefeller Foundation provided technical assistance through the contracting of (1) an "advisor" to the ICTA director, (2) the chief of the socioeconomic unit, (3) the director of the technical unit, and (4) an experiment station development expert.

All played major roles in developing the systems described in Appendix B. AID's project-funded technical assistance was directed to support national commodity programs and regional production teams. One AID contract person was promoted to director of the technical unit. Over 70 percent of

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* Lehman Bon Fletcher, Eric Graber, William C. Mernil and Erik Thorbecke, Guatemala's Economic Development: The Role of Agriculture, Iowa State University Press, Ames, Iowa, 1970.

the project's $1.7 million budget was for the contracting of expatriate assistance.* Originally this project financed coordinators of the bean, sorghum, and horticulture commodity programs; the director of pathology work in the bean program; the senior specialist and a program geneticist for maize; two regional production team directors, one of whom also directed inservice training; and later the director of the technical unit. The maize, bean, and sorghum crop programs are ICTA's major research programs.

During private individual conversations with ICTA office directors, it was their unanimous opinion that without this heavy injection of expatriate assistance, ICTA could not have benefited as quickly from the scientific work being done at the international centers and elsewhere in the world. It was also their opinion that the progress made in variety screening and testing for developing the new recommendations would not have been possible without this assistance. It was reported to us that all "advisors" integrated themselves in a team-like fashion within the ICTA system and made major contributions in their assigned work.

The timing of arrival and departure for this assistance was programmed in relationship to simultaneous massive training so that the expatriate line officers were replaced by trained Guatemalans.** Such a system served as the foundation from which research could be conducted, while simultaneously, Guatemalans were sent for advanced training. All project-funded technical assistance is scheduled to finish this year.

B. Advanced Training

Key to the temporary "replacement" of Guatemalans with expatriates was the provision of graduate level training at U.S. and third country sites (the majority went to Latin American universities) and short course training at the international agricultural centers. Under the AID project, 10 ICTA professionals (one Ph.D. and nine M.S.'s) were sent for advanced degrees. Most of them began returning from their training in January 1979, with the last one to return in September 1980. In addition, the Rockefeller Foundation has provided graduate degree assistance. For example, in 1979, 14 ICTA professionals were being sponsored to receive degrees (2 Ph.D.'s and 12 M.S.'s).

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* Principal contracts were with CIMMYT, CIAT, Texas A & M University, and Servicos Tecnices del Caribe. The remaining monies were for training--$140,000; commodity, nutritional analysis--$311,000; and miscellaneous costs.

**An example is the four and one-half year activities of contract advisor Carlos Crisostome Vergare. He started as the first coordinator of the project at La Maquina, became the Director of ICTA in Region IV, and later became the head of the Technical Production Unit in the Central Office. In each instance he was replaced by a Guatemalan who had received advanced training. After serving as the head of the Technical Unit, he served as the advisor of the new Guatemalan head for a seven-month period to assure a smooth transition.

There are many examples of the institutional improvement outcomes from this training. One such case is the seed program. In 1974, this office consisted of two professionals with no advanced training. Within a two-year period, the office director had received his M.S. in Brazil, and two technicians received courses in seed production at CIAT and CIMMYT. Resulting from this training program, a firm foundation of advanced degree agricultural and social scientists and administrators throughout ICTA was developed. These graduates replaced the original heavy input of expatriate assistance.

C. Government Support

Commensurate with the priority placed on agricultural research, the government support has increased over ten-fold over the last ten years. In 1969 (at the time the agricultural assessment was underway), the annual budget was $400,000 whereas in 1980 it was over $4,000,000. Since the initiation of AID's support, the government's budget to ICTA has more than doubled. The annual budgetary increases during the life of the project show substantial increases.

Table E-1. ICTA Annual Budget
(in millions of dollars)

1975	1976	1977	1978	1979	1980
2.0	2.3	2.9	3.3	3.8	4.7

Although there is an impressive increase associated with the project, it is still modest when compared to studies on comparative amounts spent on world agricultural research programs. A study by Boyce and Evenson concluded that a reasonable government expenditure for research would be about 2 percent of the value of gross agricultural product. Using the World Bank's Country Economic Memorandum for Guatemala (February 4, 1980) the 1979 gross agricultural product (adjusted on 1975 price index and 7 percent inflation in 1978) was $1,204 biilion. According to the "recommended" research budget levels, the government would thus have to provide an additional $19 million for research.

Though possibly insufficient in total magnitude, the results of the increased budget have greatly strengthened ICTA's institutional capacity. Whereas in 1976 ICTA had 4 Ph.D.'s, 4 M.S.'s, 86 B.S.'s, and 51 P.A.'s in their staffing pattern, in 1979 there were 3 Ph.D.'s, 15 M.S.'s, 103 B.S.'s, and 38 P.A.'s. All technical and support units except the socioeconomic

unit have been strengthened substantially.* For example, in 1976 the maize program was upgraded by the eliminatin of 5 P.A.'s and an increase of 3 B.S.'s, 2 M.S.'s, and 1 Ph.D. The sorghum unit which had but 3 P.A.'s and 1 B.S. in 1976 was increased to 4 B.S.'s, 2 M.S.'s, and 1 Ph.D. The field level technology validation unit was the most strengthened, increasing from 7 B.S.'s and 1 M.S. in 1976 to 38 B.S.'s and 3 M.S.'s in 1978.

Paradoxically, while major budget increases have permitted impressive institutional development accomplishments, additional resources to sustain this structure will be required. Budgetary limitations are perhaps the biggest constraint affecting ICTA's capacity to maintain its present system and to permit its expansion. Because of the high professional qualifications ICTA has imposed, the extensive degrees and inservice training the program has funded, and the high esteem prevailing in the private sector toward ICTA, annual attrition rates have never been less than 10 percent. Particularly vulnerable are the M.S.-level and above technicians. Three of the seven M.S.-trained ICTA personnel on board in 1976 have since departed. It is estimated that if that trend continues, within a two-year period 7 of the 17 advanced degree-trained technicians will have departed. During the time of our evaluation, the chief of the technical production unit left ICTA. He had been trained for several years by technical advisors and had received his M.S. With the departure of expatriate advisors, the future of ICTA depends upon a reversal of this significantly high attrition rate among advanced degree holders. The government must now "pay" for its successes. Although costs are high, they are justified by returns.

The concern expressed above is directed toward maintaining the existing ICTA structure. However, to address the unattended regions and to expand into fruit and vegetable production, additional numbers of highly trained professionals will be required over the next five years. Table E-2 shows ICTA projected increases. (There has been no provision for funding such a large increase in M.S. professionals over the next five years.)

To sustain this significantly increased capacity, a comprehensive study reflecting the importance to Guatemala of maintaining and strengthening the

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* Regrettably, one of the more innovative components of the project is the only one to have declined professionally. Resulting from their reluctance to be assigned to field offices and salary differences, most of the social science professionals trained by the highly regarded Rockefeller Foundation funded "advisor" departed from ICTA during 1979. The one remaining veteran left during 1978 to receive his Ph.D. but will be returning to the unit this year. Unlike the former staff which had occupied the central office, the new staff, composed of two economists and two agriculturalists (two of whom had prior ICTA field experience), has three of them assigned to Regional level offices on a full-time basis. Considering the vital role of this unit and the strengthening that has taken place ICTA-wide, this is the one unit that will require additional institutional strengthening.

ICTA system and its pool of trained agricultural and social scientists should be undertaken.

Table E-2. Increased ICTA Staffing Needs

Professional	1980	1985
P.A.	38	38
B.S.	103	130
M.S.	15	56
Ph.D.	2	3
	158	227

D. Inservice Training

Although there has been an attrition rate of noticeable importance, at the same time improved varieties and cultural practices are being developed. We believe that one explanation for this is the attention ICTA has directed to inservice training, with the result that at all levels of operation the ICTA system is well articulated and institutionalized. As a result of the knowledge transmitted through this inservice training program, when vacancies do occur, quick adjustments can usually be made. The new-comer usually arrives with a basic knowledge of what is necessary to get the job done.

A selected group of 10 new hires are given a nine-month course each year in the theory and practice of the ICTA system. The course includes ICTA methodology, problem identification, data gathering and analysis, crop technology, farm management, and communication skills. Much of the training orientation is similar to that of the CIAT training program. We were impressed with the organization and the practical orientation of the course outline. For several years, ICTA manned one of its regional production teams with trainees from this program.

One observation from our meetings with other agencies of the public agriculture sector (USPA, DIGESA, and BANDESA), was their lack of a comprehensive understanding of the ICTA technology-generation system. One means to address this deficiency and the problems cited earlier with DIGESA is the Technology Institutional Liaison course ICTA developed for DIGESA. For the second consecutive year this program has provided two-day-a-week training courses to selected DIGESA programs. When the ICTA budget was readjusted because of increased gasoline costs, some DIGESA participants decided to pay their own transportation costs instead of dropping out. This indicates the dedication of some DIGESA personnel.

Program expansion based on an extension of ICTA's professional role and an increase in program understanding on the part of non-ICTA participants will require the development of new inservice training programs.

In conclusion, it can be said that in relation to the original project purpose of improving ICTA's institutional capacity, every selected "indicator" has been surpassed. This accomplishment has had some unanticipated outcomes. The present model is serving an international audience of agricultural planners and researchers as a model for possible replication. A structure similar to ICTA's is being developed in Honduras. The Consortium for International Development is sending 32 Latin American researchers to ICTA to observe the ICTA system. The IDB is also preparing a $20 million loan to further assist ICTA.

Our concern is not over the accomplishments of this project at the end of its present association with AID, but rather, over how an institutional structure so impressive in its present arrangement can be maintained and expanded. Additional government support to cover higher salary levels is one issue that will require closer attention.

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